(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 521 719 A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 92306112.1

(51) Int. Cl.[5]: B60C 23/00

(22) Date of filing: 02.07.92

(30) Priority: 05.07.91 US 726067

(43) Date of publication of application: 07.01.93 Bulletin 93/01

(84) Designated Contracting States: AT CH DE ES FR GB IT LI NL SE

(71) Applicant: EATON CORPORATION
Eaton Center, 1111 Superior Avenue
Cleveland, Ohio 44114-2584 (US)

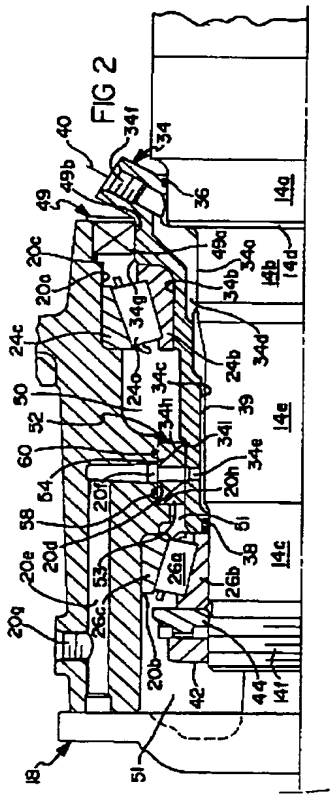
(72) Inventor: Schultz, Gary Richard
9920 Springwood Drive
Kalamazoo, Michigan 49009 (US)
Inventor: Runels, Thomas Lee
136 S. Lincoln Boulevard
Battle Creek, Michigan 49015 (US)
Inventor: Freigang, Alan Richard
8415 Shirley Court Apartment 11
Portage, Michigan 49002 (US)
Inventor: Ziech, James Foltan
3409 Bronson Boulevard
Kalamazoo, Michigan 49008 (US)

(74) Representative: Wright, Peter David John et al
R.G.C. Jenkins & Co. 26 Caxton Street
London SW1H 0RJ (GB)

(54) Drive axle sleeve and seal assembly.

(57) A land vehicle wheel end assembly (16) for a rigid tubular drive axle assembly (10) includes a nonrotatable sleeve (34) interposed between a portion of a spindle (14) of the axle assembly and a wheel hub (20). The wheel hub is rotatably supported on the spindle by inboard and outboard bearings (24,26) lubricated by oil from the drive axle. The hub includes a passage for directing the oil to the inboard bearing (24). The sleeve and hub include air passages (34f,34d,34e and 20e) for directing air from a vehicle onboard central tire inflation system to a pneumatic tire supported by the hub. A relative rotational interface between the sleeve and hub air passages is sealed by a seal assembly (52) which is lubricated by the oil. An outboard end of the sleeve preferably includes an axially open annular groove (45 or 47) for inserting an O-ring (38) seat therein after installation of the sleeve on the spindle.

FIG 2



EP 0 521 719 A1

Field of th Invention

This invention relates to apparatus for transmitting air to and from tires of a drive axle for a vehicle having an onboard or central tire inflation system (CTI system). More specifically, the invention relates to a sleeve and seal assembly for transmitting the air from a nonrotatable portion of the CTI system air circuit to a wheel hub rotatably mounted on a spindle of the drive axle.

Background of the Invention

Onboard CTI systems are known, as may be seen by reference to U.S. Patents 4,640,331; 4,498,515; 4,898,216 and 4,917, 163 which are incorporated herein by reference. Further, it is known to provide apparatus for transmitting the CTI system air from a nonrotating portion of the CTI system air circuit to a wheel hub rotatably mounted on the spindle of the drive axle, as may be seen by reference to U.S. Patents 2,978,906; 3,362,452; 4,418,737; 4,730,656 and 4,804,027 which disclose such apparatus in detail and which are incorporated herein by reference.

The prior art apparatus of each of the above patents has certain disadvantages which are overcome by the apparatus of this invention. For example, the apparatus of this invention: requires little or no modification of a standard drive axle and is therefore ideal for retrofit applications; does not require the drilling of long passages in hardened steel components such as axle spindles or sleeves; does not require nonstandard or special wheel bearing components; positions dynamic air seals for the CTI system between the inboard and outboard bearings of each drive axle wheel hub where they are protected from dirt and grime, and are readily lubricated by the drive axle lubricating oil; avoids encroachment into the sometimes hot and always limited space for the wheel brakes; provides the CTI system with air passages of adequate flow area while maintaining the total volume thereof rather low.

Summary of the Invention

An object of this invention is to provide improved apparatus for transmitting air from a nonrotatable portion of a CTI system air circuit to a wheel hub rotatably mounted on a spindle of a drive axle.

According to a feature of the invention, a vehicle drive axle assembly is adapted for use with a vehicle onboard system for controlling tire air pressure. The axle assembly comprises a rigid tubular housing including a hollow nonrotatable spindle at opposite ends thereof and a rotatable drive shaft assembly having opposite ends thereof extending through an outboard nd of each spindle for driving a wheel hub rotatably supported on each spindl . Each spindle includes a radially outwardly facing surface having first, second and third surfaces concentric to an axis of the spindl and respectively of progressively less r diameter. The first and second surfaces respectively extend from an axially outboard facing shoulder. The third surface extends axially inboard from a set of fastener threads in the outwardly facing surface at the outboard end of the spindle and axially separated from the second surface by an intermediate surface. The wheel hub is rotatably supported on the spindle by bearing means including inboard and outboard axially spaced apart bearing assemblies radially interposed between the second and third surfaces and radially inwardly facing surfaces of the hub. Each bearing has an inner and an outer race. A fastener is threadably received by the spindle fastener threads and reacts against the outboard bearing inner race for securing the hub on the spindle. A sleeve defines passage means for directing fluid pressure from a position inboard of the inboard bearing assembly to a hub passage having an opening radially aligned with a passage extending radially through a cylindrical wall of the sleeve at a position between the bearing assemblies. The sleeve includes inboard and outboard ends having means in sealing relation with the first and third surfaces, a radially inwardly facing surface sealed on the second surface, a radially outwardly facing surface supporting the inboard bearing inner race, another radially inwardly facing surface between the second and third surfaces defines an annular passage in cooperation with the spindle intermediate surface, and a groove in the sleeve inwardly facing surfaces. The groove has an outboard end communicating with the radially extending passage in the sleeve via the annular passage. The groove has an inboard end communicating with a passage in the sleeve inboard end with the passage opening into the groove inboard end at a position inboard the sleeve sealing relation with the first surface. First and second annular seals are disposed on axially opposite sides of the hub and sleeve radially extending passage and both seals are in sealing relation with radially inwardly and outwardly facing surfaces respectively of the hub and sleeve for providing a sealed annular passage between the radially extending passages.

Brief Description of the Drawings

The apparatus of the invention is shown in the accompanying drawings in which:

Figure 1 is a sectional view of a drive axle wheel end assembly;

Figure 2 is an enlarged portion of the wheel end assembly in Figure 1;

Figure 3 is an enlarged sectional view of a sleeve in Figures 1 and 2;

Figure 4 is an end view of the sleeve looking in the direction of arrow 4 in Figure 3;

Figure 5 is an enlarged fragmentary view of a sta-

tic seal arrangement at an outboard end of the sl eve;
Figures 6 and 7 are alternatives to the seal arrangement of Figure 5; and
Figure 8 is an enlarged sectional view of dynamic air seals in Figures 1 and 2.

Detailed Description of the Drawings

Figure 1 illustrates one end of a land vehicle drive axle assembly 10 including a rigid tubular housing 12 having a hollow spindle 14 disposed at each outboard end for rotatably supporting a wheel end assembly 16 driven by a drive shaft assembly 18 extending at each end through each spindle. The shaft assembly includes a flange 18a an attached to a wheel hub 20 via fasteners 22. The hub is supported for rotation about an axis A by inboard and outboard roller bearings 24, 26 of standard configuration. Bearings 24, 26 respectively include tapered rollers 24a,26a, inner races 24b,26b, and outer races 24c,26c. The bearings are lubricated by the axle assembly lubricating oil which enters the wheel end assembly via clearance between the shaft assembly and the hollow spindle. A drilled passage 20a in the hub directs the oil to the inboard bearing. Each axle assembly end also includes a support Mange 28 for an unshown brake mechanism which cooperates with a partially shown brake drum shown in phantom lines 30. The drum is affixed to hub 20 via studs 32 which also secure an unshown rim supporting a pneumatic tire in known manner.

Looking now mainly at Figures 2, 3, and 4, spindle 14 includes finished annular radially outwardly facing surfaces 14a, 14b and 14c concentric to axis A and respectively of progressively less diameter, an axially outboard facing shoulder 14d, an intermediate surface 14e, and a threaded end 14f. An annular sleeve 34 includes inboard and outboard ends having annular grooves for retaining O-ring seals 36,36 which sealingly cooperate with spindle surfaces 14a,14c, an annular radially inwardly facing surface 34a seated on spindle surface 14b, an annular radially outwardly facing surface 34b supporting the inboard bearing inner race 24b, a radially inwardly facing surface 34c between spindle surfaces 14b,14c defining an annular passage 39 in cooperation with spindle intermediate surface 14e, and an air passage groove 34d in the sleeve inwardly facing surfaces. An outboard end of the groove 34d communicates with one or more radially extending passages 34e in the sleeve and an inboard end of groove 34d communicates with a passage 34f in the sleeve inboard end at a position inboard of O-ring seal 36. Passage 34f communicates with an unshown vehicle onboard central tire inflation/deflation system via a conduit 40.

Sleeve 34 is secured against axial movement relative to spindle 14 in th inboard direction via shoulder 14d and in the outboard direction via outboard bearing inn r race 26b and fast ners 42,44 threadably received by threaded nd 14f of th spindl in known manner. O-ring seal 38, as also shown in enlarged Figure 5, is preferably but not necessarily positioned in an annular axially outwardly opening groove 45 (seen in Figure 3) and retained in position by a ring 46 disposed between the O-ring and an axially inboard facing surface 26d of inner race 26b. Precise positioning of inner race 26b may require shims disposed between inner race surface 26d and the outboard end of the sleeve. The preferred axial opening of groove 45 facilitates installation of O-ring 38 after installation of sleeve 34 and thereby mitigates the chances of injury to the seal during installation.

Alternatively, as seen in Figure 6, an axially open but shorter groove 47 may be employed, thereby dispensing with ring 46 and employing inner race surface 26d or the above mentioned shims to directly retain the O-ring seal. Still further, if O-ring seal injury is not a problem during sleeve installation, a conventional O-ring groove 48 may be employed as seen in Figure 7.

Hub 20 includes radially inwardly facing surfaces including annular surfaces 20a,20b,20c and 20d, and an air passage 20e. Surfaces 20a,20b support the hub on bearing outer races 24c,26c. The inboard end of the annular space 50 between the sleeve and hub is closed by a seal 49 having an outer periphery press fit into annular surface 20c and having an inner periphery defining elastomeric lips 49a,49b forming dynamic sealing relations with an annular surface 34g of sleeve 34. Lip 49a prevents leakage of the axle oil lubricating bearing 24 in the annular space between the sleeve and hub, and lip 49b excludes entry of dirt and grim into the annular space. Air passage 20e includes a radially extending portion having an opening 20f extending through surface 20d at a position in radial planar alignment with sleeve passages 34e and having an opening 20g for connection to an unshown pneumatic tire in any of several known manners. Leakage of air flow between passages 34e,20e to annular spaces 50,51 containing the bearing lubricating oil and leakage of the oil to the air passages is prevented by a seal assembly 52. The seal assembly, shown in enlarged detail in Figure 8, includes two double lip elastomeric seals 53,54 axially spaced apart and affixed to an annular ring member 56 in slip fit relation at its outer periphery with surface 20d. Leakage of fluid along the annular spaces 50,51 containing the bearing lubricating oil and leakage of the oil to the air passages is prevented by a seal assembly 52. The seal assembly, shown in enlarged detail in Figure 8, includes two double lip elastomeric seals 53,54 axially spaced apart and affixed to an annular ring member 56 in slip fit relation at its outer periphery with surface 20d. Leakage f fluid along the interface surface 20d and ring member 56 is prevented by O-ring seals 58,60 retained in grooves in surface 20d. Ring mem-

b r 56 includes one or more p nings 56a for flow of air between passages 20e,34 . Elastomeric lips 53a,53b and 54a,54b of seals 53 and 54 form dynamic sealing relations with an annular radially outwardly facing surface 34h of sleeve 34 and are lubricated by the oil in annular spacer 50,51. Lips 53a,54a prevent air leakage to the oil in annular spaces 50,51 and may, as configured herein, move into tighter sealing relation with surface 34h in response to increasing air pressure. Lips 53b,54b exclude entry of the oil into the air passages. Hub shoulder 20h maintains the axial positioning of seal assembly 52. Alternatively, an unshown bracket may be affixed to ring member 56 and hub 20 to retain the seal assembly against axial and rotational movement relative to the hub.

A preferred embodiment of the invention has been disclosed for illustrative purposes. Many variations and modifications of the preferred embodiment are believed to be within the spirit of the invention. The following claims are intended to cover the inventive portions of the preferred embodiment and variations and modifications within the spirit of the invention.

Claims

1. A vehicle drive axle assembly (10) adapted for use with a vehicle on board system for controlling tire pressure, the axle assembly comprising:

a rigid tubular housing (12) including a hollow nonrotatable spindle (14) at opposite ends thereof and a rotatable drive shaft assembly (18) having opposite ends thereof extending through an onboard end of each spindle for driving a wheel hub (20) rotatably supported on each spindle;

each spindle (14) including a radially outwardly facing surface having first (14a), second (14b) and third (14c) surfaces concentric to an axis (A) of the spindle (14) and in order of lesser diameter, the first (14a) and second (14b) surfaces extending axially outboard from an outboard facing shoulder (14d), the third (14c) surface extending axially inboard from fastener threads (14f) in the outwardly facing surface at the outboard end of the spindle and axially separated from the second surface (14b) by an intermediate surface (14e);

bearing means (24,26) for rotatably supporting the wheel hub (20) on the spindle (14), the bearing means (24,26) including inboard (24) and outboard (26) axially spaced apart bearing assemblies radially interposed between the second (14b) and third (14c) surfaces and radially inwardly facing surfaces of the hub (20c,20b), each bearing having an inner race (24b,26b) and an outer race (24c, 26c);

a fasten r (42) threadably received by th spindl fastener threads (14f) and reacting against the outboard bearing inner race (26b) for securing the hub (20) on the spindle (14);

a sleeve (34) defining passage means (34f,34d,39,34e) for directing fluid pressure from a position inboard the inboard bearing assembly (24) to a hub passage (20e) having an opening (20f) radially aligned with a passage (34e) extending radially through a cylindrical wall of the sleeve (34) at a position between the bearing assemblies (24, 26);

the sleeve including inboard and outboard ends having means (36,38) in sealing relations with the first and third surfaces (14a,14c), a radially inwardly facing surface (34a) seated on the second surface (14b), a radially outwardly facing surface (34g) supporting the inboard bearing inner race (24b), another radially inwardly facing surface (34c) between the second and third spindle surfaces (14b,14c) defining an annular passage (39) in cooperation with the spindle intermediate surface (14e), a groove (34d) in the sleeve inwardly facing surface (34a,34c), the groove (34d) having an outboard end communicating with the radially extending passage (34e) in the sleeve (34) via the annular passage (39), the groove (34d) having an inboard end communicating with a passage (34f) in the sleeve inboard end, the passage (34f) opening into the groove (34d) inboard end at a position outboard the sleeve sealing (36) relation with the first (14a); and

first and second annular seals (53,54) disposed on axially opposite sides of radially extending passages (20f) in the hub (20) and sleeve (34) with both seals in sealing relation with radially inwardly and outwardly facing surfaces (20d,34h) respectively of the hub (20) and sleeve (34) for providing a sealed annular passage between the radially extending passages (34e,20f).

2. The vehicle drive axle assembly of claim 1, wherein:

the sleeve outboard end disposed inboard of the outboard bearing inner race (26b), and the seal means (38) including an annular radially inwardly open groove means (38) having an O-ring seal (45) therein in sealing relation with an inboard portion of the third surface (14c).

3. The vehicle drive axle assembly of claim 2, wherein:

the annular groove means (38) also including an annular axially outward opening to facilitate of the O-ring (45) after installation of the sleeve (34) on the spindl (14).

4. The vehicle driv axl ass mbly of claim 3,

wh rein:

an axially inboard facing surface of th onboard bearing inner race (26b) maintains the O-ring (45 or 47) in the annular groove (38).

5. The vehicle drive axle assembly of claim 3, wherein:

the seal means (38) includes an annular ring (46) received by the annular axially outward opening (38) and sandwiched between the O-ring (45) and an axially inboard facing surface of the onboard bearing in race (26b).

6. The vehicle drive axle assembly of claim 1, wherein:

the first and second annular seals (53,54) include annular lip portions (53a,53b,54a,54b) in dynamic sealing relation with the outwardly facing surface (34h) of the sleeve (34) and include support means (56) in static sealing relation with the hub inwardly facing surface (20d).

7. The vehicle drive axle assembly of claim 6, wherein:

the seal support means (56) includes an annular ring member (56) having the seals (53,54) affixed to a radially inwardly facing surface thereof, having a radially outwardly facing surface thereof in the static sealing relation, and having a radially extending opening (56a) therein for communicating the hub passage (20f) with the annular passage defined by the seals (53,54).

8. The vehicle drive axle assembly of claim 1, further including:

lubricating means (21) for lubricating the inboard and onboard bearings with oil from the rigid tubular housing (12), the lubricating means including

an oil passage (21) in the hub for directing the oil from a position outboard of the outboard bearing assembly (26) to the inboard bearing assembly (24).

9. The vehicle drive axle assembly of claim 8, wherein:

the first and second annular seals (53,54) each include a first and second annular lip portions (53a,53b,54a,54b) in dynamic sealing relation with the outwardly facing surface (34h) of the sleeve, the first lips (53a,54a) for preventing leakage of the air flowing between the radially extending passages in the hub (20) and sleeve (34), and the second lips (53b,54b) lubricated by the oil and preventing leaking of oil to the passages.

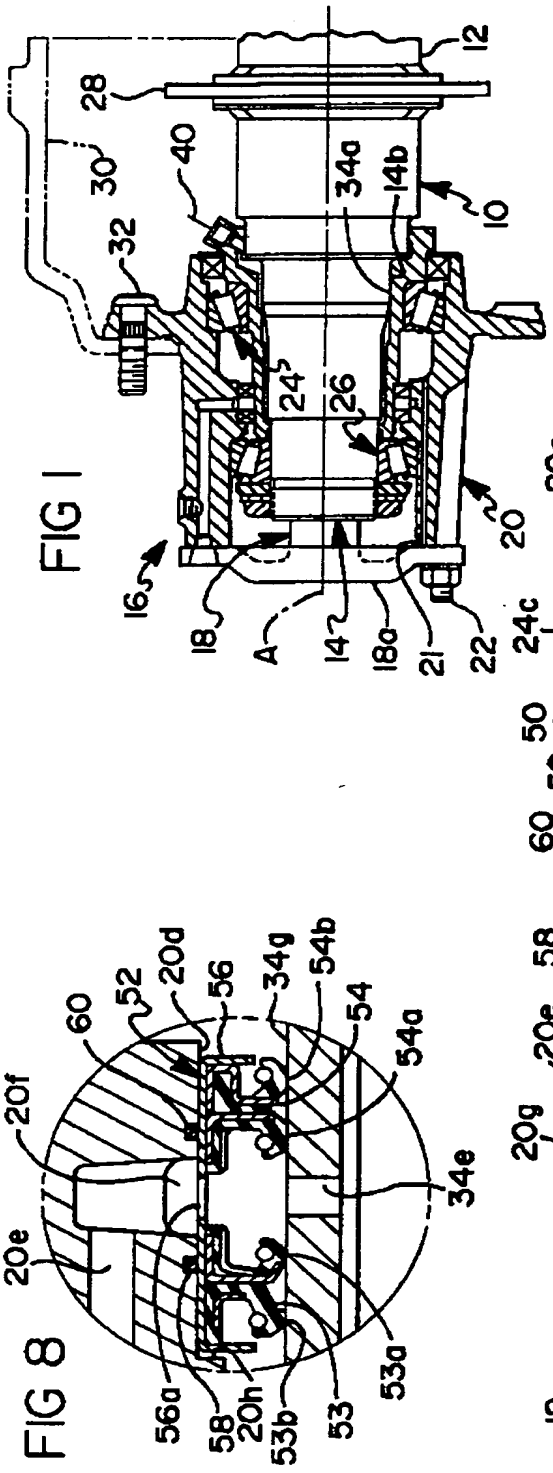


FIG 1
12
28
30
40
32
34a
14b
10
24
26
20
16
18
A
14
18a
21
22

FIG 8
20f
60
52
20d
56
34g
54b
54
54a
34e
20e
56a
58
20h
53b
53
53a

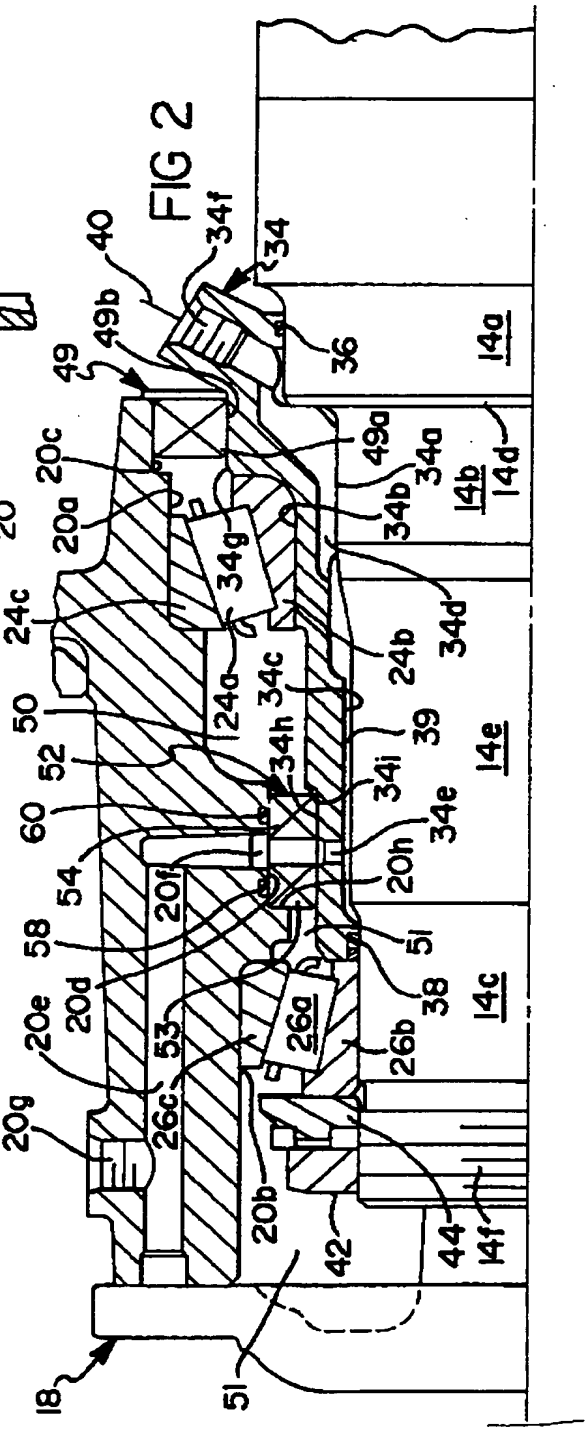


FIG 2
40
34f
34
49b
49
36
14a
20c
49a
34a
20a
34b
14b
14d
34g
24c
34d
24b
24a
34c
50
34h
39
52
34i
14e
60
34e
54
20h
20f
58
5i
20d
38
14c
26a
20e
53
26b
26c
20g
20b
42
44
14f
18
5i

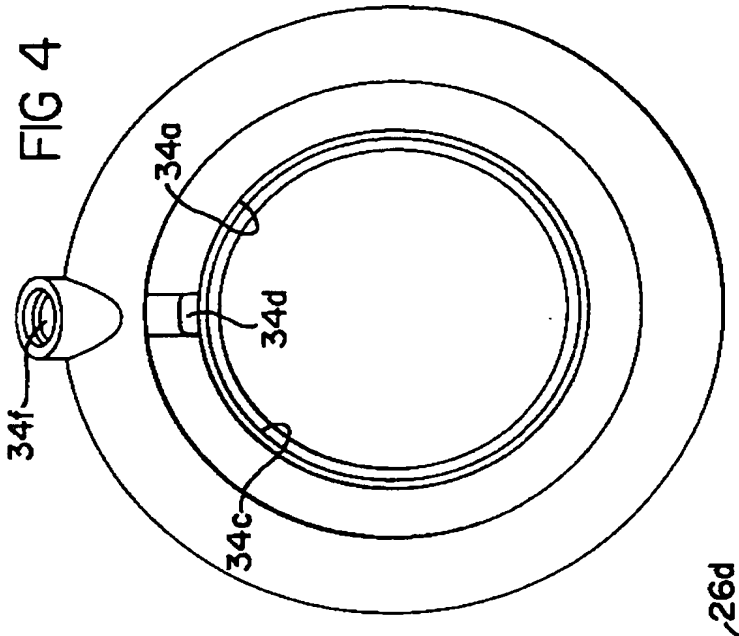


FIG 4

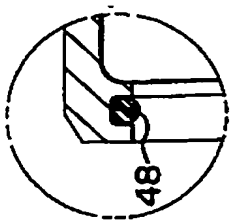


FIG 7

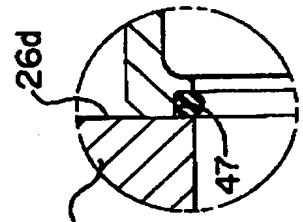


FIG 6

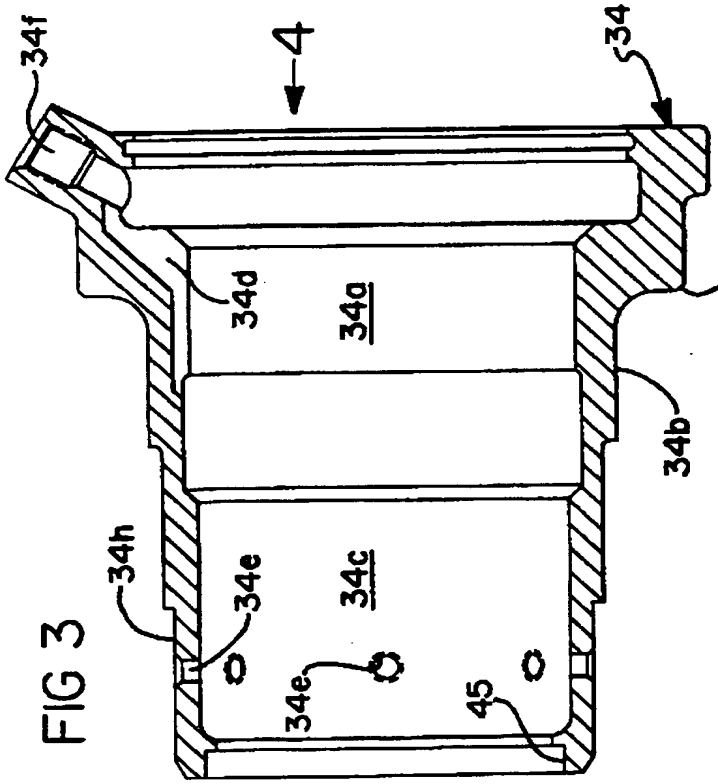


FIG 3

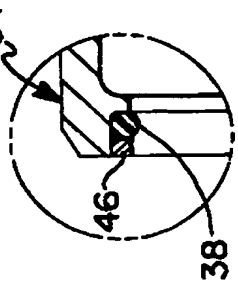


FIG 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 92 30 6112

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-3 362 452 (HARNISH) * the whole document *	1	B60C23/00
A	EP-A-0 410 723 (NISSAN) * column 5, paragraph 2; figures 1,4 *	1,8	
P,A	US-A-5 080 156 (BARTOS) * column 8, line 55 - column 10, line 4; figure 2 *	1-5	
A	EP-A-0 224 674 (MANN) * abstract; figure 1 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B60C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 SEPTEMBER 1992	HAGEMAN M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)